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RESOURCE MANAGEMENT METHOD FOR A VIRTUAL COMPUTER SYSTEM

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2. Claim

Resource management method for a virtual computer system characterized in that, with virtual computer system provided with a program (10) having a resource allotment control element (14) which manages the resource allotment of individual virtual computers (11 – 13), the individual virtual computers (11 – 13) have resource usage quantity measurement elements (15 – 17) which examine the usage quantity during operation with respect to the allotted resources; the resource allotment control element (14) gathers data on the resource usage quantity for the respective virtual computers (11 – 13), judges the excess or deficiency of the resource allotment quantity for the respective virtual computers (11 – 13), and dynamically optimizes the resource allotment quantity.

3. Detailed Explanation of the Invention

[Outline]

Concerning a resource management method for optimally allotting resources such as memory and the like dynamically in a virtual computer system, the objective is to offer a means whereby a guest's virtual computer and the virtual computer control program are associated during their operation and the usage rate of the allotment resources are evaluated; based on the result, the allotment quantity with respect to the respective virtual computers is dynamically changed, and optimization can be realized; this is comprised in that, with virtual computer system provided with a program having a resource allotment control element which manages the resource allotment of individual virtual computers, the individual virtual computers have resource usage quantity measurement elements which examine the usage quantity during operation with respect to the allotted resources; the resource allotment control element gathers data on the resource usage quantity for the respective virtual computers, judges the excess or deficiency of the resource allotment quantity for the respective virtual computers, and dynamically optimizes the resource allotment quantity.

[Field of Use in Industry]

The present invention concerns a resource management method for optimally allotting resources such as memory and the like dynamically in a virtual computer system.

With a virtual computer system, multiple virtual computers are formed on one actual computer in accordance with requirements from the user, and they can be operated simultaneously in a parallel manner.

With the computer control programs (hereinafter referred to as "CP") that manage the respective virtual computers, when a virtual computer (hereinafter referred to as "VM") is established, resources such as memory (virtual memory), CPU usage rate, and the like are allotted.

In general, these are allotted to VM's and there is a limit to the total quantity of allotable resources; however, the necessary resource quantity for individual VM's varies based on the processing state, and at times, excesses and deficiencies in the resources allotted to the individual VM's are generated.

[Prior Art Technology]

With conventional virtual computer systems, the resources allotted to the respective VM's of the guest were designated before the guest VM is set up, and when the need arose to change the allotment quantity during system operation, the operator intervened and changed it.

Therefore, changes in the allotment quantity of resources could not be carried out frequently, and the quantity of resources allotted to each VM often did not coincide with the actual state of usage.

Figure 5 shows a temporal change in the memory usage quantity with a guest VM. In this case, there are many periods where the usage rate is not associated with 100%, and it is evident that there is a surplus. In contrast to this, with other guest VM's, many of the time periods and allotted resources are 100% used; they are insufficient, and waiting for processing can occur.

[Problems the Invention is Meant to Resolve]

With conventional VM system resource management systems, it has been difficult to manage resource allotment quantities adequately. Excesses and deficiencies have been generated on the respective VM's, and the overall resource usage efficiency has been poor. In particular, with VM's having insufficient resource allotment quantities, there have been problems in that the processing performances has been reduced due to the fact that processing has been slow, throughput has been small, and the like.

The objective of the present invention is to offer a means whereby a guest VM and a VM control program are associated during their operation, the allotment usage rate is judged, and in accordance with the results, the resource allotment rate for each VM is dynamically changed, and optimization can be realized.

[Means for Resolving Problems]

Figure 1 is an explanatory diagram of the principles of the present invention.

In the drawing, (10) is a virtual computer control program (expressed as CP).

(11) through (13) are virtual computers (expressed as VM1, VM2, and VM3).

(14) is a resource allotment control element provided inside the CP.

(15) through (17) are resource usage quantity measurement elements provided inside the OS of the respective VM's.

The resource allotment control element (14) of the CP has a control function whereby the initial allotment of resources to the respective VM's and the allotment quantity during operation of the VM's are changed.

The resource usage quantity measurement elements (15 – 17) have the function of measuring the actual usage quantity of the resources allotted to their own VM's, and extracting the data.

[Operation]

In Figure 1, the CP resource allotment control element (14) allots resources for the initial quantity established in advance for each respective VM when they are set up.

The resource usage quantity measurement elements (15 – 17) measure the usage quantity of the allotted resources at a fixed timing during operation, and store the data.

The CP resource allotment control element (14) has a control function for changing the initial allotment of resources to the respective VM's and the allotment quantity during operation of the VM's.

[Operation]

In Figure 1, the CP resource allotment control allots the initial resources respectively set in advance when the respective VM's are set up.

With the resource usage measurement elements (15 – 17) of the respective VM's that are set up, the usage rates of the allotted resources are measured at a fixed timing during operation, and the data are maintained.

The CP resource allotment control element (14) gathers data on the resource usage quantity maintained by the resource usage measurement elements (15 – 17) of the respective VM's, judges the necessity or non-necessity of changing the allotment quantity from the usage rate of the allotted resource quantity for the respective VM's, and a redistribution of resources is carried out if necessary. In this case, the allotment quantity of a VM with a low resource usage rate is decreased, and the allotment quantity of a VM with a high resource usage rate is increased.

Figure 2 is an explanatory diagram of the operation of the present invention. The resource allotment quantity for the VM is dynamically changed, and the side having undergone optimization is shown.

Figure 2(a) shows memory resources allotted when VM1, VM2, and VM3 are set up. The resource usage rates of the respective VM's at some point in time are 100%, 40%, and 70% respectively, as shown in the drawing.

As shown in Figure 2(b), the fixed memory region shown by the arrow from VM2 is detached, and as shown in Figure 2(c), a change in the resource allotment added to VM1 is carried out.

Based on this, as shown in Figure 2(d), the memory of VM2 is contracted, the memory of VM1 is expanded, and the respective memories are operated. A balance is achieved for the loads in the respective VM's.

Afterwards, the memory usage rate of the respective VM's is examined at an appropriate time, and redistribution of the memory resources is carried out based on the situation. Thus, an optimum memory quantity is allotted to the respective VM's consistently.

[Embodiment]

Next, the specifics of the present invention are explained in accordance with an embodiment.

Figure 3 is an explanatory diagram of the memory resources allotted to a random VM (shown as VMn) in an embodiment of the method of the present invention.

The region on the actual memory allotted to VMn is a fixed block of a continuous address region surrounded by a front address A and a final address B. The virtual address on VMn is easily converted to an actual address by adding the front address A.

Figure 4 shows a resource management control means in an embodiment of the method of the present invention. ① through ⑧ in the drawing show the respective steps of the control means.

① The used or unused (empty) regions of the respective VM's are examined. For example, the presence of an unused region shown by the slanted lines in VM2 is detected.

② The status of used and unused regions of the memory for the respective VM's, corresponding to an inquiry from a CP, is notified to the CP. In this case, VM2 notifies the CP of the unused region, and VM1 notifies of a memory insufficiency.

③ The CP judges an excess or deficiency of the allotment quantity based on the memory usage state of the respective VM's, and determines a course of change if necessary. For example, moving of the memory region from VM2 to VM 1 is determined.

④ The CP first requests that the unused region of VM2 be removed.

⑤ VM2 relocates the unused region to a random address side and removes it; then, it informs the CP that the removal is complete.

⑥ The CP expunges the memory allotment quantity for VM2, and executes a structural change to the VM resources added to VM1.

⑦ The CP is notified of the allotment addition to VM1 of the memory region of the corresponding part of the unused region of VM2.

⑧ VM1 incorporates the added memory region and manages it in a usable state.

In this manner, the CP and respective VM's are associated, and optimization processing whereby the random allotment resources are dynamically redistributed, is carried out.

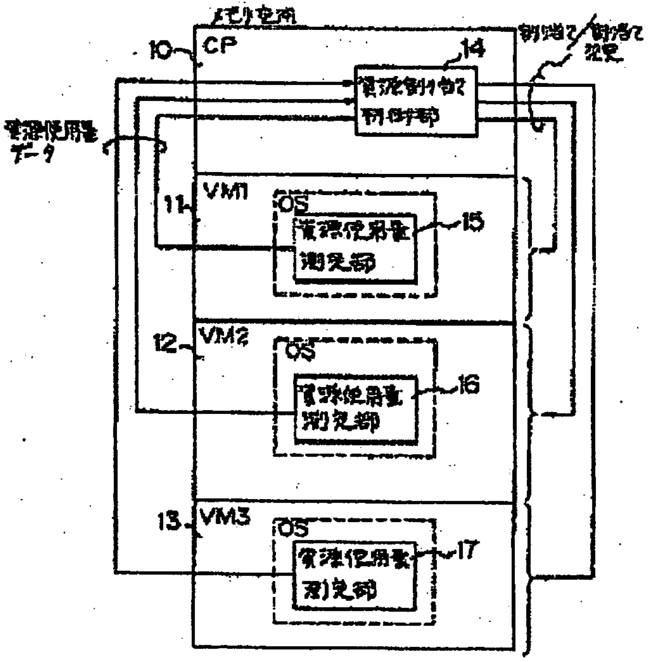
[Results of the Invention]

Based on the present invention, even when there is a change in the load at a random VM, because of the fact that resources can be redistributed dynamically to achieve a balance, the effective use of resources can be accomplished. Additionally, improvements in the throughput of the entire system and in processability are possible.

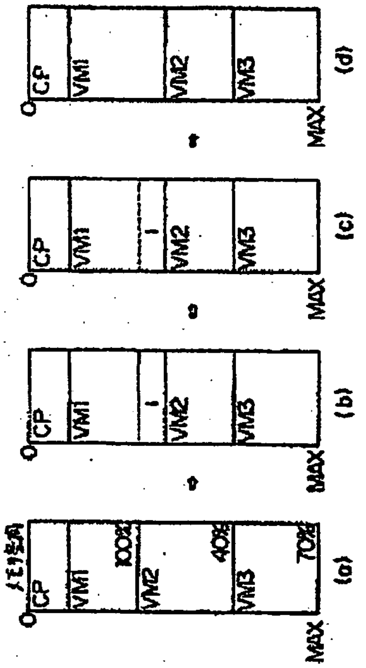
4. Simple Explanation of the Drawings

Figure 1 is an explanatory diagram of the principles of the present invention. Figure 2 is an explanatory diagram of the operation of the present invention. Figure 3 is an explanatory diagram of the memory resources allotted to a random VM in an embodiment of the method of the present invention. Figure 4 shows a resource management control means in an embodiment of the method of the present invention. Figure 5 shows an example of a temporal change in the memory usage quantity with a conventional guest VM.

In Figure 1, (10) is a virtual computer control program (expressed as CP); (11) through (13) are virtual computers (expressed as VM1, VM2, and VM3); (14) is a resource allotment control element provided inside the CP; and (15) through (17) are resource usage quantity measurement elements provided inside the OS of the respective VM's.

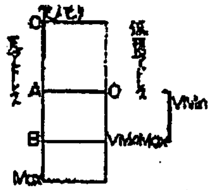

メモリ空間
10
CP
14
割当て/割当て変更
資源割当て制御部
資源使用量データ
11
VM1
OS
資源使用量測定部
15
12
VM2
OS
資源使用量測定部
16
13
VM3
OS
資源使用量測定部
17

本発明の原理説明図
第1図


メモリ空間
0
CP
VM1
100番
VM2
400番
VM3
700番
MAX
(a)
(b)
(c)
(d)

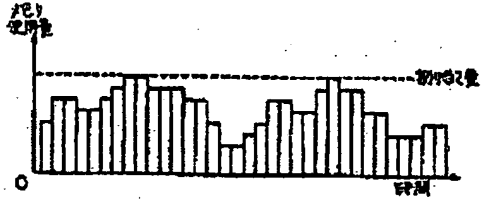
本発明の作用説明図

第2図


実メモリ
実アドレス
仮想アドレス
0
A
0
VMin
B
VMMax
Max

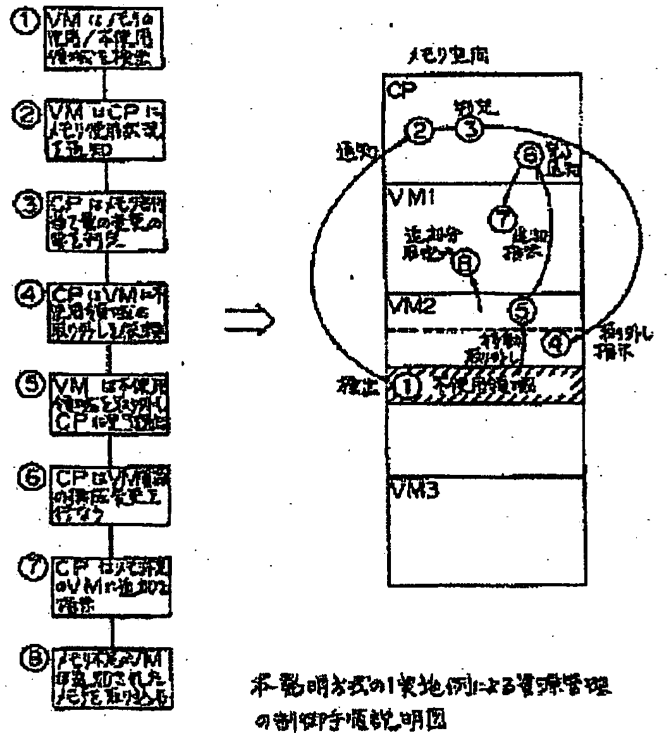
本発明方式の1実施例において
VMに割り当てられるメモリ領域の説明図

第3図



従来のゲストVMにおけるメモリ使用量の時間的変化
の例を示す説明図

第5図


① VMはメモリの使用/不使用領域を検出
② VMはCPにメモリ使用状況を通知
③ CPはメモリ割当て量の変更の要否判定
④ CPはVMに不使用領域の取り外しを依頼
⑤ VMは不使用領域を取り外しCPに通知
⑥ CPはVM領域の再配置を行なう
⑦ CPはメモリ不足のVMに追加を指示
⑧ メモリ不足のVMは追加されたメモリを取り込む
⇒
メモリ空間
CP
判定
②
③
通知
⑥
割当通知
VM1
⑦
追加指示
追加分取込み
⑧
VM2
⑤
領域取り外し
④
取り外し指示
検出
①
不使用領域
VM3

本発明方式の1実施例による資源管理
の制御手順説明図

第4図

Translations Branch
United States Patent and Trademark Office